# I. INTRODUCTION

## PLAN DEFINITION AND PURPOSE

The Lower West Coast (LWC) Water Supply Plan is a guide for addressing future water demands in Southwest Florida. The purpose of the plan is to set a framework around which future water use decisions in the LWC Planning Area can take place.

The plan is to be used as a tool to guide decisions regarding planning, research, funding, and regulatory issues related to water supply in the LWC Planning Area. It is not intended to be implemented in and of itself. Although this plan does contain recommendations, each of these recommendations must be considered and implemented by a corresponding action taken at a later time. The LWC Water Supply Plan makes future water demand projections and sets a water use framework which is to be implemented by the District through regulatory, research, planning, construction, operational, land management, and acquisition actions. It will also be implemented through actions taken by other governmental entities and public or private organizations.

This plan does not guarantee water for specific users or uses, nor does it supersede or override the District's permitting process. Instead, the plan projects water demands and recommends certain actions take place within the planning horizon -- between now and the year 2010. This plan is not self-executing. The plan represents overall approaches and guidelines for integrating water resource management activities. Implementation of all programs and projects identified in the plan will require specific actions through public processes, such as SFWMD board approval, permits, rulemaking, and interagency agreements.

## PLANNING AREA DESCRIPTION

The LWC Planning Area includes all of Lee County, most of Collier and Hendry counties, and portions of Charlotte, Glades, Dade, and Monroe counties. Only Lee County is entirely within the planning area; the remaining counties are partially within other regional planning areas of the SFWMD (Figure 1). The portions of these counties within the LWC Planning Area are referred to as the Collier, Hendry, Charlotte, Glades, Dade, and Monroe "County Areas." The boundaries of the LWC Planning Area generally reflect the drainage patterns of the Caloosahatchee River basin and the Big Cypress Swamp. The northern boundary corresponds to the drainage divide of the Caloosahatchee River, which is also the SFWMD/SWFWMD jurisdictional boundary in Charlotte County, while the eastern boundary delineates the divide between the Big Cypress Swamp and Everglades system. The area east of this divide is in the Lower East Coast Planning Area.

The LWC Planning Area covers approximately 4,300 square miles and has a humid, subtropical climate. It is characterized by low topographic relief and a high water table. General types of land use in the planning area include agriculture, urban areas, wetlands, forest, and rangeland. A more detailed description of the planning area is provided in Chapter I of the LWC Background Document.

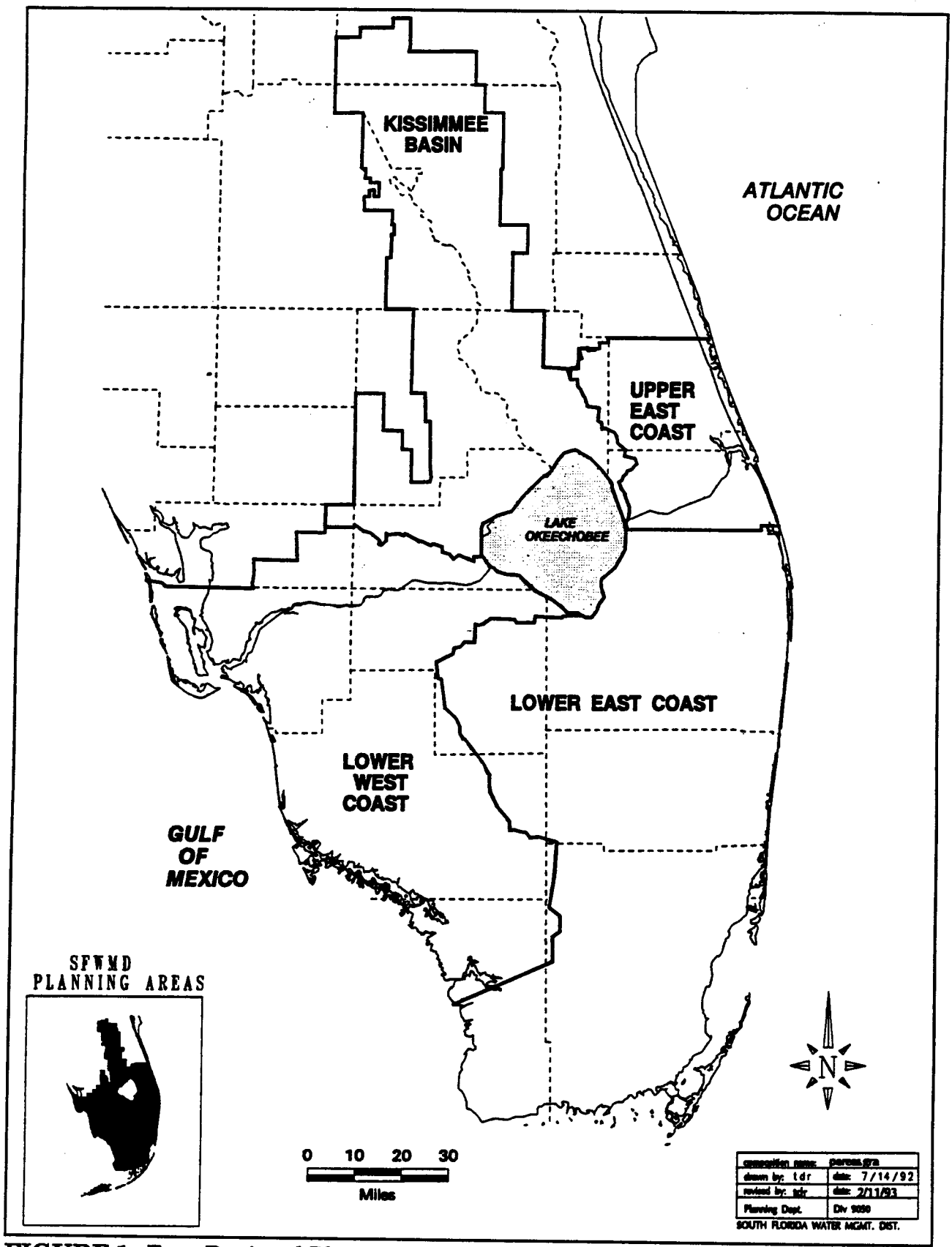


FIGURE 1. Four Regional Planning Areas.

## GOALS, DIRECTIVES AND POLICIES

A critical component in the development of the LWC Water Supply Plan was the establishment of its guiding goals, directives and policies. Acknowledging the highly interdependent and rigorous data requirements of a comprehensive water management plan, this initial LWC Water Supply Plan was to focus foremost on the primary water supply and demand characteristics of the planning area. In so doing, the quantification of current and future uses (predominantly ground water), simulation of these ground water uses (modeling) and generation of variable alternatives to alleviate problem areas is the singular emphasis of this initial plan. Thus this plan's primary purpose is to identify the most significant short- and long-term water resource problems and to lay out the initial recommended steps needed to ensure an adequate availability of water supply. Future updates to this plan will incorporate greater emphasis on issues of surface water management, water quality, flood protection, and economic and feasibility analyses.

With the focus of the plan being aimed at assuring availability of an adequate water supply for all reasonable-beneficial uses (see Goal, below), the applicable water supply plan guiding directives and policies were selected. These directives and policies were chosen from the Water Supply Policy Document (SFWMD, 1991), State Water Policy (Chapter 17-40 F.A.C.) and Chapter 373, Florida Statutes (F.S.). These select guiding directives and policies are the underlying themes of this plan, those directions and activities which are most applicable and prudent at this preliminary stage of water supply planning for the LWC Planning Area. The overall goal together with the guiding directives and policies are the targets toward which this plan is aimed. However, as previously noted, the goal, directives, and policies of this plan are not self-executing. The SFWMD Governing Board, by accepting this plan, is directing staff to develop more detailed information for future board actions related to budgeting, operations, and the initiation of the rulemaking process. The potential impacts, if any, to certain water users, or classes of water users, related to these future board actions cannot be determined at this time.

### GOAL

**To assure the availability of an adequate supply of water for all competing uses in the Lower West Coast Planning Area deemed reasonable and beneficial while maintaining the functions of natural systems.**

### Water Supply Plan Guiding Directives and Policies

The District should seek to:

- Prevent wasteful, uneconomical, impractical or unreasonable uses of the water resources.

- Examine whether it is reasonable to continue to protect the inefficient withdrawal practices of some presently existing legal users.

- Maximize levels of certainty for legal water users through defining certainties which a legal user can expect a permitted allocation to be protected from interference by other legal users, or from reduction by climatic events or other water shortages, for the duration of the permitted allocation.

- Protect and enhance environmental resources while providing appropriate levels of service for drainage, flood control, water storage and water supply.

- Prohibit practices which result in aquifer compaction and aquifer dewatering to preserve productivity and quality of water supply.

- Manage water withdrawals to minimize salt water intrusion or upconing of saline water.

- Flood protection shall be implemented within the context of other interrelated water management responsibilities (Section 17-40.450, F.A.C.)

## Community and Governmental Relations Guiding Directives and Policies

- Provide guidance to local governments to ensure that water resource impacts are considered in land use decision-making.

- Encourage regional planning to develop solutions to water supply problems. When appropriate, this will include the utilization of local source such as utility interconnects, regional water supply planning, regional well fields, regional water authorities or other measures which diversify supply sources without adding new demands on the regional supply system.

- Engage in planning to assist counties, municipalities, regional water supply authorities, private utilities, and others in meeting water supply needs. Strongly encourage local governments to give priority to implementing water conservation measures, reducing or eliminating adverse environmental effects that may result from improper or excessive withdrawal of water from concentrated areas, and diversifying supply sources to reduce demand-related stress on natural systems.

- Municipalities, counties and regional water supply authorities are to have the primary responsibility for water supply, and water management districts and their basin boards are to engage only in those functions that are incidental to the exercise of their flood control and water management powers.

The implementation of the LWC Water Supply Plan will require a series of future decisions by the Governing Board of the South Florida Water Management District on policy issues. These issues are anticipated to include: (1) revisions to the District's Basis of Review for water use permits; (2) allocation of water among competing classes of water users; (3) program funding for recommended research and testing and cooperative projects with local governments; and (4) adoption of minimum flows and levels.

## PLAN COMPONENTS

The LWC Water Supply Plan includes three documents:

- *Planning Document (Volume I):* This document describes the results of the ground water modeling process and presents recommendations that address potential problems identified by the modeling.

- *Background Document (Volume II):* This document provides data, assumptions, and potential water supply options for use by the District, the Advisory Committee, other agencies, counties, municipalities, individual utilities, and various interested parties in the development and implementation of the LWC Planning Document. In addition, the water resource modeling and impact evaluation procedures used in the Planning Document are introduced. Volume II contains a list of references for all LWC Water Supply Plan Documents.

- *Appendices (Volume III):* This document provides technical information that supports the Planning and Background Documents.

## MAJOR FACTORS INFLUENCING THE PLAN

The major factors influencing this plan are those that influence the availability of water. Ground water availability is defined by proposed State Water Policy as the potential quantity of ground water which can be withdrawn without resulting in significant harm to the water resources or associated natural systems. Surface water availability is similarly defined by State Water Policy as the potential quantity of surface water which can be removed or retained without significant harm to the water resources or associated natural systems [Section 17-40.210, (13) and (33), respectively (draft State Water Policy of December 6, 1993)].

The major factors influencing the availability of water in the LWC Planning Area include: (1) dependency upon rainfall falling within the planning area, (2) limited surface water sources, (3) protection of water resources and associated natural systems, and (4) pressure on these resources from increasing urban and agricultural demands. Competition among users of water is potentially another factor.

The factors introduced in this section are considered to be most influential in the development of the LWC Water Supply Plan. Some of these factors form the cornerstone of the resource protection criteria that are discussed later in this chapter.

### Rainfall Dependency

Water availability in the LWC Planning Area depends primarily upon rainfall incident upon the planning area. This water is stored mostly in wetlands and the Surficial Aquifer System. Average annual rainfall in the LWC Planning Area ranges from 51.8 inches in Hendry County to 54.5 inches in Collier County. However, the distribution of rainfall changes from season to season and year to year. Nearly two-thirds of annual rainfall occurs during the May to October wet season when demands are moderate. The remaining third occurs during the dry season months (November through April), when the demands are largest.

## Surface Water Availability

The Background Document reports that the only significant source of surface water in the planning area is the Caloosahatchee River (C-43). This source of water, however, is unreliable during the dry season or extended periods of deficient rainfall, when releases are required from Lake Okeechobee to meet demand. The C-43 is managed by the U.S. Corps of Engineers via a regulation schedule which presently accommodates navigational, flood protection, water supply, and environmental needs. It is possible that the C-43 may be able to yield additional amounts of water during the wet season for aquifer storage and recovery (ASR), a technique which stores excess water by injecting it into an aquifer, where it can later be recovered when needed. However, there is significant institutional and technical uncertainty regarding the feasibility of untreated surface water ASR from the standpoints of water quality and permitting.

The LWC Planning Area contains large expanses of wetlands and natural surface water systems; however, with the exception of the Caloosahatchee River (C-43 Canal), which provides water to the City of Fort Myers and portions of Lee and Hendry counties, there is no regional surface water delivery system to bring water from outside the region into the planning area. Therefore, there are currently few regional opportunities to supplement surface water or recharge ground water with deliveries via a regional canal system.

## Protection of Water Resources and Associated Natural Systems

Ground water is the principal source of supply in the planning area. Ground water availability in this plan is evaluated with respect to resource protection criteria. The resource protection criteria described in this plan were designed to prevent significant harm to water resources and associated natural systems. Excessive declines in ground water levels adversely impact the quality and quantity of water available from an aquifer or aquifer system. Examples of this include saltwater intrusion, aquifer compaction, and decreased well yields. Excessive declines may also cause a decrease in the hydroperiod of wetland systems which leads to the displacement of plant and animal species.

## Current and Future Demand

Southwest Florida is one of the fastest growing regions in the nation. The estimate of total population of the LWC Planning Area for 1990 was 513,000. The total population is projected to increase 90 percent to 976,000 in 2010. During the 20-year period, overall water demand (predominantly ground water) is projected to increase by approximately 54 percent from 307,000 to 472,000 million gallons per year (MGY). Public water supply (defined as urban users who are not self supplied) has the largest projected increase of 97 percent, as public utilities intend to serve a larger portion of the region's population. However, agricultural water demand is projected to remain the single largest category of use. (Refer to Chapter IV of the LWC Background Document for further information on demand estimates and projections).

Citrus demand is the largest category of agricultural use in the LWC Planning Area, which has the fastest growing citrus acreage of any area in Florida. The initial clearing, draining, and planting, and subsequent water withdrawals required to establish agricultural operations replaces natural habitats and modifies the natural hydrology of the area. However, a recent study performed by the University of

Florida Institute of Food and Agricultural Sciences (IFAS) indicates that citrus groves and their water management systems may provide significant value as habitat.

Urban growth in Lee and Collier counties also has the potential to impact the region's environmental and water resources. Drainage of wetlands for urban expansion, loss of natural surface water storage areas, and contamination from urban land use (e.g., storm water runoff and industrial pollution), are the major water-related issues in urban areas. In the densely populated coastal areas, seawater intrusion has forced some of the water treatment facilities to relocate their water supply well fields further inland.

As a result of the existing and potential water supply problems, most of the LWC Planning Area is designated as a Critical Water Supply Problem Area. Proposed revisions to State Water Policy will change this designation to Water Use Caution Area, with wastewater reuse required in these areas through the District's consumptive use permitting process. There are also two other specially designated areas in the planning area: Reduced Threshold Areas and Areas of Special Concern. In Reduced Threshold Areas, the threshold separating a general permit from an individual permit has been lowered from the average daily allocation of 100,000 GPD to 10,000 gallons per day (GPD). Areas of Special Concern are designated in areas where either there are limitations on water availability or there are other potentially adverse impacts associated with a proposed withdrawal.

The modeling analysis of water supply alternatives for this plan focused upon Lee County and those portions of Collier and Hendry counties within the LWC Planning Area because most of the current and projected demand occurs in these areas. However, agricultural demand estimates were developed for the Charlotte County and Glades County portions of the planning area. There are no agricultural or urban demands for the Dade and Monroe county areas because these areas entirely consist of portions of Everglades National Park and the Big Cypress National Preserve. The portion of Dade County within the LWC Planning Area is too small to effectively be represented in the LWC Water Supply Plan. More detailed information on the water demand for these areas is contained in the Background Document.

## ROLE OF THE LWC ADVISORY COMMITTEE

One important aspect of the water supply plan development for the LWC Planning Area was the formation of a broad-based advisory committee consisting of 49 representatives from interested and affected parties in the study area. Committee participants included representatives from utilities, agribusiness, government, environmental interest groups and others. The responsibility of this committee was to review and comment on the LWC Background Document, and to advise and participate in development of the LWC Planning Document. The advisory committee provided an effective forum for all interested parties to participate in plan development. The committee met 12 times and all meetings were advertised and open to any interested members of the public that wished to attend.

## OUTSTANDING NATURAL SYSTEMS

The Outstanding Natural Systems (ONS) concept and map (Figure 21 on p. 65) were developed as a result of public input to the LWC Water Supply Planning process. The January 1992 draft of the LWC Water Supply Plan projected that drawdown levels for the water table aquifer through the year 2010 would result in impacts to natural systems within the region. As a protection strategy, the draft plan recommended that no drawdowns be allowed to occur beneath natural systems. The LWC Advisory Committee expressed concern that the "no drawdown" restriction would eliminate further development of the water resources; yet they recognized the need to ensure protection of certain large natural systems (i.e., Big Cypress National Preserve, Fakahatchee Strand, Corkscrew Sanctuary, Okaloacoochee Slough, etc.) from the impacts of ground water withdrawals. Therefore, the Advisory Committee requested that District staff re-evaluate ways to protect the large natural systems from unacceptable impacts resulting from ground water withdrawals while allowing further development of the water resources of the region.

To address the advisory committee concerns, District staff proposed two levels of protection (from ground water withdrawals) for natural systems: (1) the "base" level that all natural systems are subject to, and (2) an "elevated" level for the large, relatively pristine natural systems within the LWC Planning Area. The elevated level of protection will be provided through implementation of recommendations 19, 20, and 21 on page 64. The areas to receive the elevated level of protection would be known as "Outstanding Natural Systems" (ONS).

The LWC Advisory committee endorsed the "ONS" concept and appointed a subcommittee to identify and map the large, natural systems (ONS lands) which should be preserved to ensure the ecological integrity of the region. The subcommittee was comprised of representatives from public utilities, environmental groups, the agricultural community, Big Cypress Basin, the SFWMD, the Florida Game and Fresh Water Fish Commission, U.S. Geological Survey, and county governments. Meetings were held every two to three weeks for a nine month period until the map was completed.

Initial meetings focused on developing criteria for preparing the ONS map. The group agreed that large areas which could be considered relatively pristine natural systems should be included within the ONS boundary. It was agreed that ONS areas should be predominately wetlands, due to their sensitivity to hydrologic changes. However, uplands would also be included where they formed a mosaic with wetlands, provided corridor links between wetlands, or were known to support endangered species. Additionally, the group agreed that all Outstanding Florida Waters (OFWs), estuaries, and large tracts of lands (public and private) purchased for conservation/preservation purposes would automatically be included within the ONS boundary (i.e., Rookery Bay Aquatic Preserve, Big Cypress National Preserve, Corkscrew Sanctuary, etc.).

The criteria used to prepare the ONS map include:

Automatic Inclusion Criteria

(1) Lands purchased with public funds for conservation/preservation purposes;

(2) Large wetland and/or upland areas, purchased with private funds for conservation/preservation purposes;

(3) Outstanding Florida Waters (includes Aquatic Preserves); or

(4) Estuaries.

Automatic Exclusion Criteria

(1) Existing natural areas which have been permitted for development. (Only permitted areas known to work group members were excluded; a systematic search of permit files was not conducted).

Other Inclusion Criteria

(1) Large - wetland and/or upland areas greater than 300 acres (based on analysis of the ONS map);

(2) Relatively pristine natural systems - lands composed mostly of native vegetation or areas where man has replaced the native community with non-native vegetation but the replacement community (i.e., pastures) still provides valuable habitat for native animals;

(3) Connected - physical connections of wetlands and/or uplands via hydrologic or biological corridors; or biological connections of isolated ONS lands (i.e., "stepping stones" for native fauna);

(4) Corridors - areas which are at least 100 meters wide (based on analysis of the ONS map) and which hydrologically and/or biologically link other ONS lands;

(5) Endangered, threatened or species of special concern - Significant natural areas inhabited by species listed by the Florida Game and Fresh Water Fish Commission within or connected to the larger systems. Note not all listed species or their habitats are contained within the ONS boundaries.

Lands that are large, relatively pristine, and connected, as defined above, were included within the ONS boundary. In a few instances, lands adjacent to the ONS boundary known to support endangered species, threatened species, and/or species of special concern were included within the ONS boundary. Additionally, agricultural reservoirs were evaluated by the work group on a "case-by-case" basis. A limited number of reservoirs were included because of their location and/or habitat quality.

Through group consensus, it was decided that the ONS lands would be divided into two categories to reflect current land uses. The ONS lands that have been purchased for environmental preservation/conservation purposes would be designated as ONSe lands. The ONS lands that are currently used for multiple purposes (i.e., agriculture, residential, water supply, surface water management, etc.) would be designated ONSm lands.

Once the general criteria were agreed to, the map was prepared by analysis of high altitude, color infrared aerial photographs (Winter 1990-91; Scale = 1:40,000) based on vegetation, visible hydrology, local knowledge of the region, and limited ground truthing. Copies of the aerial photographs were pieced together, mounted on foam board, and covered with mylar. Subcommittee members delineated ONS boundaries on the mylar covers with grease pencils. All ONS lines were agreed to through a consensus process. The boundaries were then digitized in AutoCAD and converted to ArcInfo coverages. Due to the scale of the map and inherent limitations of using aerial photographs, developed and agricultural lands exist within the ONS

boundary. In addition, certain natural areas that have significant ecological value lie outside the ONS boundary.

Implementation strategies for the ONS map include, use as: (1) a planning tool, (2) a focus for research efforts, and (3) a guide for identifying appropriate off-site regional mitigation areas. The ONS map will serve as a planning tool in guiding compatible uses in and adjacent to ONS lands. For example, Lee County Regional Water Supply Authority used an initial version of the ONS map in conjunction with transmissivity maps to avoid locating future wellfields and their associated drawdowns within or adjacent to ONS lands.

ONS lands will be targeted for District research. The ONS research will focus on developing a better understanding of the relationship between ground water withdrawals and wetland impacts in order to ensure an acceptable level of protection to natural systems while allowing reasonable use of the ground water resources.

Additionally, the ONS map will be used to identify regional off-site mitigation areas. Areas within or adjacent to the ONS boundaries that have been impacted by human activities will be identified as potential regional mitigation sites. Assessments will be conducted to determine the type and amount of restoration and/or enhancement activities needed. Ultimately, a master plan of the regions mitigation sites will be developed based upon the ONS map.

## RESOURCE PROTECTION CRITERIA

The resource protection criteria developed for this plan are standards to prevent significant harm to wetlands and ground water resources caused by the pumping of ground water. These criteria were developed through a process that included: (1) consultation with District staff professionals who had years of experience in permitting of water uses in the LWC Planning Area, (2) input from members of the LWC Advisory Committee and the Outstanding Natural Systems Subcommittee, and (3) consultation with recognized environmental specialists from the region. The resource protection criteria define the severity, duration, and frequency of declines in ground water levels.

Ground water levels decline to their lowest levels during extremely dry periods, making it difficult to satisfy resource protection criteria for wetlands and ground water while meeting all water demands. Because of this difficulty, the District's water supply planning efforts and its regulatory program for water use permits are directed to: (1) meet demands for reasonable-beneficial uses of water during average to moderately dry conditions, and (2) manage water shortages during extremely dry conditions. For the purposes of this plan, extremely dry conditions (or deficit conditions) are defined to be droughts that occur no more frequently than once in ten years on the average.

### Wetland Protection Criterion

This criterion applies to the shallow aquifer system in areas that have been classified as a wetland according to the National Wetlands Inventory. The wetland criterion is generally defined as follows: *Ground water level drawdowns induced by pumping withdrawals should not exceed 1 foot for more than 1 month during any drought event that occurs as frequently as once every ten years in areas that are classified as a wetland.*

## Seawater Intrusion Protection Criterion

This criterion applies to selected locations along the Gulf Coast in Lee and Collier counties based on evidence of historical seawater intrusion or upon geologic evidence of susceptibility to seawater intrusion at these locations. Minimum allowable ground water levels in the intermediate and shallow aquifer systems were chosen for these locations to prevent seawater intrusion except during more extreme drought events. The seawater intrusion criterion is generally defined as follows: *Ground water levels should not decline below the selected, site-specific level for any period of time during any drought event that occurs as frequently as once every ten years.* Appendix K shows the locations where the seawater intrusion protection criterion were defined for ground water modeling.

## General Aquifer Protection Criterion

The general aquifer protection criterion is defined as follows: *Ground water levels should not decline below the selected, site-specific level for any period of time during any drought event that occurs as frequently as once every ten years.* It applies to all confined aquifers in the LWC Planning Area, and is based on recognition of the fact that reduction of ground water levels below certain stages produces undesirable results. Such 'undesirable results' may include: aquifer compaction and dewatering, reduced well yields, land subsidence, upconing of saline water, and adverse impacts on existing water users. Of the possible impacts listed, only the most extreme, aquifer compaction and dewatering and the resultant reduction in well yields, are directly addressed in this stage of the plan.

To prevent these impacts, ground water levels must not be allowed to fall below the elevation of the top of the aquifer. The minimum allowable ground water levels (criteria levels) were set at the estimated location of the top of the aquifer plus a safety buffer equivalent to the approximate uncertainty of the estimate. For example, if the top of the aquifer is estimated to be at an elevation of 50 feet below sea level (-50 ft NGVD) with an uncertainty of 10 feet, then the criteria level would be set at 40 feet below sea level (-40 ft NGVD). The general aquifer protection and seawater intrusion protection criteria water levels represent minimum levels beyond which serious adverse impacts to ground water resources are likely to occur. It is the District's intent not to allow water levels to fall below these levels under any conditions. In contrast, the wetland protection criterion levels can be viewed as environmental resource management levels: The cumulative impacts of allocations using the wetland protection criteria based on a 1-in-10 drought should not result in water level declines that will significantly harm the ground water resource. Appendix K shows the general aquifer protection criterion levels that were used for ground water modeling.

The general aquifer protection criterion levels applied in this document should be thought of as the minimum allowable water levels. The levels for protecting the resource may need to be higher when other potential impacts not currently considered by this criterion (e.g., upconing of saline water and impacts to existing users) are evaluated. At present, there is insufficient data available within the planning area regarding the location, quality, and movement of saline waters to establish any quantitative criteria for protection against upconing. Collecting information sufficient for this purpose should be among the District's other research efforts for the LWC Planning Area. Identification of adverse impacts to existing users is not feasible at the regional scale of the water supply plan, and is best left to the regulatory process.

## MINIMUM FLOWS AND LEVELS CONCEPT

The native ecosystems of South Florida have been heavily impacted by alterations designed to increase the amount of land suitable for agricultural use and residential, commercial, and industrial development. Drainage and land-filling activities have lowered water tables, substantially modified natural hydroperiods, eliminated wetlands, degraded water quality, and diminished critical habitat for fish and wildlife.

State policy establishes the goal that land and water development occur in a manner that does not degrade environmental quality. The establishment of the minimum flows for surface water courses and levels for surface waters and aquifers is critical to maintaining environmental quality. In recognition of this fact, the Florida Legislature has mandated that all water management districts establish minimum flows and levels for water bodies within their jurisdictions (Section 373.042, F.S.). Minimum flows of water bodies represent the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area; minimum levels are the level of ground water in an aquifer and the level of surface water at which further withdrawals would be significantly harmful to the water resources.

Environmentally defined minimum flows and levels will be set by the SFWMD to protect water bodies, water courses, associated wetlands, and aquifers from significant harm caused by water withdrawal or diversion. Minimum flows and levels will be established on a priority basis which will be more fully defined in the District Water Management Plan and future regulatory criteria. As required by s. 17-40.473, F.A.C., established minimum flows and levels will be protected through water use permitting, water shortage declarations, and through construction and operation of water resource projects. Moreover, establishment of minimum flows and levels is only one source of statutory authority by which the goal of environmental protection can be achieved. Additional provisions of Chapter 373, F.S., direct the water management districts to reserve water for environmental purposes such as fish and wildlife. These additional sources combined with the minimum flow and level directive yield a package of provisions aimed at reserving water for environmental demands. The resource protection criteria detailed in this plan are, once adopted through rulemaking, intended to implement these statutory authorizations.

The definition of minimum flows and levels is a complex legal issue, but the underlying concept is relatively simple. Natural systems are adapted to certain patterns of freshwater flows. Changes in flows can alter and degrade these systems. The purpose of reserving water for the environment is to avoid uses of water that would cause significant harm to natural areas. A decline in the functions and values of wetland systems is interpreted to be significant harm.

While the need to avoid significant degradation of natural systems is important, it must be accomplished in a world where human uses occur. In addition to considering the benefits of environmental protection and enhancement to an area, the District must consider its other water management objectives in setting minimum flows and levels. A balance between the objectives of environmental enhancement, flood protection, and providing water for other beneficial uses must be achieved. This balance must reflect the need to provide environmental protection while allocating water for human needs with a consumptive use permitting system that is based on a specified drought event.

It is the District's intention not to allow flows and levels to decline below minimum flows and levels, because such declines would cause significant harm to water resources and/or the environment. However, water flows and levels are likely to fall below those flows and levels that would occur during the specified drought event that is used as the basis for allocating water (issuing permits). In some cases, flows and levels could potentially decline below minimum flows and levels in the absence of a water shortage plan to prevent such declines. Water shortage plans should explicitly recognize certain warning flows and levels that are above the minimum flows and levels. These warning levels can be used as thresholds, or triggers, below which cutbacks in water use must occur in order to maintain flows and levels above the minimum flows and levels. A series of progressively more stringent cutbacks can be correlated with a series of progressively declining water flows or levels. These thresholds, or triggers, will need to be developed in the rulemaking process using the criteria levels in this plan as a guide.

Reservation of water for environmental purposes in South Florida must incorporate the natural variation in hydrologic conditions that occurs on a seasonal and annual basis. Native ecosystems have evolved life cycles based on this fluctuation. The establishment of minimum flows and levels in a manner that disregards natural hydrologic fluctuations could create serious environmental problems. For example, water deliveries to Everglades National Park across the Tamiami Trail were at one time regulated by a minimum delivery schedule that changed by month, but did not vary from year to year. Better results have been obtained with a more complex schedule that is adjusted on the basis of actual rainfall measurements. This rainfall-based approach reflects the natural situation where flow would have occasionally stopped entirely.

Minimum flows and levels are important in the assessment of water supply sources because they effectively limit the cumulative or temporal quantities of water which may be withdrawn. For this reason, estimates of the water needs of natural systems will occur as part of the development of the water supply plans for each of the regions within the District. As was the case with the resource protection criteria that were used for analytical purposes in this plan, minimum flows and levels which will be developed through future rulemaking are likely to incorporate the three conditions of frequency, duration, and severity.

Water supply within the LWC Planning Area is derived primarily from ground water. Accordingly, the Lower West Coast Water Supply Plan generally focuses on ground water-related issues and impacts of increased water use on wetlands. Because of the reliance on ground water as a supply within the LWC Planning Area, minimum flows for the Caloosahatchee River will not be addressed in the Lower West Coast Water Supply Plan; these will be developed as part of the Lower East Coast Regional Water Supply Plan since the major source of water for the Caloosahatchee is Lake Okeechobee. Climatic conditions and the operation of Lake Okeechobee directly influence releases to the Caloosahatchee and St. Lucie Estuaries and the Lower East Coast. Recommended minimum flows for the Caloosahatchee River will be presented in the Lower East Coast Regional Water Supply Plan. The draft Lower East Coast Water Supply Plan is scheduled for completion in October 1994.

### Minimum Levels - LWC Aquifer Systems

On the Lower West Coast, sensitive environmental areas that are likely to be impacted by future ground water level drawdowns have been identified and resource

protection criteria have been generated to ensure that water resource development activities do not jeopardize hydroperiods or related habitats.

Upon acceptance of this plan by the SFWMD Governing Board, rulemaking will be initiated to adopt the resource protection criteria; resource protection criteria will not be implemented in advance of final rule adoption. The seawater intrusion and general aquifer protection criteria will define the minimum level to avoid harm to the ground water resources of the region. The wetland protection criteria will prevent significant harm to wetland systems due to the impacts of ground water withdrawals.

Along with the initial analyses involving hydrologic and hydrogeologic models, a longer term effort to develop analytic tools and monitoring programs which can further link changes in water flows and levels to changes in habitat will be developed. The successful development of these tools will allow the enhancement of measures to protect wetlands from ground water drawdowns.

### Minimum Flows and Levels - LWC Surface Water Systems

As outlined in the LWC Background Document, the majority of the surface water bodies in the region are canals that were constructed for drainage purposes or tidally influenced creeks and rivers. Minimum flows and levels for these systems will be established on a priority basis. Priorities will be based on the potential for significant harm to natural systems resulting from alterations in quantities and/or timing of flows. Man-made canals will be prioritized based on the extent to which they contribute to downstream and upstream impacts. Tidally influenced creeks and rivers will be evaluated with respect to historic flows. A comprehensive schedule for developing surface water minimum flows and levels in the LWC Planning Area will be included in the District Water Management Plan. As discussed above, minimum flows for the most significant surface water resource in the planning region, the Caloosahatchee River, will be established as part of the Lower East Coast Water Supply Plan.

## GROUND WATER MODELING

### Base Case Model Runs

Ground water flow models of the shallow aquifers (Surficial and Intermediate aquifer systems) in Collier, Lee and Hendry counties were used to evaluate how well resource protection criteria could be met for future water demands under average and deficit rainfall conditions. Based on these results, water supply problem areas were delineated. Problem areas are defined as areas where the resource protection criteria were not met. Alternative water supply/demand modeling scenarios were developed to examine how well they might reduce the extent of the problem areas.

All three flow models use the U.S. Geologic Survey "Modular Three-Dimensional Finite-Difference Ground-Water Flow" (MODFLOW) code. The Collier and Hendry models were previously developed by the SFWMD and the Lee model was developed by a consultant under contract to the Lee County Regional Water Supply Authority. The models simulate ground water flow and associated ground water levels within the Surficial, lower Tamiami, Sandstone, and mid-Hawthorn aquifers for any given set of well withdrawals, canal configurations and precipitation.

Two water demand levels were examined using ground water flow models: (1) The 1990 permitted demand level, and (2) the 2010 projected demand level. The 1990 permitted demand level represents the total urban and agricultural water demand that was permitted by the District through the end of 1990. The 2010 projected demand level is based on estimates of population in 2010 and acreage that will actually be irrigated in 2010.

The 1990 permitted demand level is considerably higher than actual 1990 demand level because considerably more agricultural acreage was permitted in 1990 than was actually planted. Actual crop acreages are usually less than the permitted acreages due to the normal lags between permitting and planting. These lags vary in length, based on planting schedules, fluctuation in current and anticipated crop prices, long-range expansion plans, and short-term management decisions made by the growers.

Permitted acreage may run far ahead of the actual acreage in an area experiencing high growth in agricultural acreage. The difference between permitted acreage and actual acreage is somewhat smaller in areas experiencing slower growth in agriculture, such as Lee County. Because the 1990 permitted demand level is so much greater than the actual 1990, the projected 2010 demand level is only slightly higher than the 1990 permitted demand level.

All simulated irrigation demands varied with rainfall conditions based on meeting irrigation requirements as defined by the modified Blaney-Criddle method in the Basis of Review Permit Information Manual, Volume III (SFWMD, 1993). Public water supply and domestic self supply demands varied on a monthly basis based on historic monthly distribution patterns.

Two rainfall conditions were simulated to identify the difference between likely chronic problems, occurring under average rainfall conditions, versus problems expected only during droughts. Drought conditions were simulated for each county using the historic 12 month rainfall event causing simulated water level declines expected to be equaled or exceeded approximately once every 10 years on average. This rainfall event is called a 1-in-10 drought condition.

"Base case" model runs were simulated using both the 1990 permitted demand level (1990 base case) and the 2010 projected demand level (2010 base case). Assumptions for the 2010 base case represent what was expected to occur in the future without any additional water supply planning and regulation. The 2010 base case model runs assumed that future water users would obtain their water from the same aquifers as existing users. It also assumed that existing water users would utilize the same aquifers for both their current and future demands.

Base case model run results were evaluated to determine how well resource protection criteria had been met. The wetland protection criterion utilizes drawdowns in layer one of the model and is applicable only under wetlands. Water levels from a model run with no wells pumping (well package turned off) were compared to water levels with the wells pumping to determine drawdowns in each of the layer one model cells. Drawdowns in layer one of the model were evaluated to determine in which model cells the wetland criterion drawdown limit (one foot for more than one month) had not been met. Wetlands overlying these model cells were identified, and the total area of the wetlands where the criteria had not been met was calculated for each model run. The total area in which wetland criteria had not been

met (expressed in acres) was used to compare how well various model runs met the wetland protection criterion.

The seawater intrusion and general aquifer protection criteria specify minimum water levels for model cells. Model run results were checked for compliance with these criteria by directly comparing the water levels from each model run with the criteria levels. The model cells in which criterion levels had not been met were identified. Additionally, the number of months during a model run in which a criterion level had not been met within each model cell was observed and assigned to each cell as a weighting factor. The weighting factors from each model run were summed and then used as a relative index for comparing how well the various model runs had met the seawater intrusion and general aquifer protection criteria. Dimensionally, this relative index may be expressed in units of "cell months." For example, a model run in which water levels fell below a criterion level in one model cell for two months was reported to have a relative index of two cell months. A model run in which water levels fell below criterion levels in two model cells for two months in one cell and three months in the other cell would have a relative index of five cell months.

## Alternative Modeling Scenarios

In addition to the base case model runs, several alternative water supply/demand modeling scenarios were simulated using the 2010 projected demand level. These alternative modeling scenarios were evaluated for their effectiveness in meeting the resource protection criteria in the same way as the base case model runs. The results from each alternative modeling scenario were compared to the results from the base case model run at the 2010 projected demand level. The effectiveness of each scenario compared to the base case was expressed as a percentage reduction in the total area not meeting the wetland protection criterion or as a percentage reduction in the relative index for the seawater intrusion and general aquifer protection criteria. For example, the total area where wetlands had not met the wetland protection criterion for each alternative modeling scenario was compared to the total wetland problem area for the base case model run at the 2010 projected demand level. The result was expressed as a percentage reduction in total wetland problem area compared to the base case model run.

### Scenario 1 - Evaluate reduction of public water supply demands from the shallow aquifers

Two variations on this model scenario were simulated for both Collier and Lee counties. Public water supply demand is a relatively small component of the total demand in Hendry County, so scenario 1 was not simulated for Hendry County. All public water supply withdrawals were removed from the shallow aquifers in scenario 1a. This scenario eliminated any problems in not meeting the resource protection criteria due to public water supply withdrawals. In scenario 1b, the increase in public water supply withdrawals between the 1990 permitted demand level and 2010 projected demand level was removed from the shallow aquifers. Scenario 1b isolates the effect of the increased public water supply demand with respect to meeting the resource protection criteria. Although both modeling scenarios 1a and 1b remove the current or future public water supply demand from the shallow aquifers, neither scenario specifies nor simulates an alternative source for these demands. The most probable alternative source for these demands is the Floridan Aquifer System; however, simulation of flow in the Floridan cannot be done with the existing models.

A more detailed analysis must be performed with shifting the withdrawals of different user classes (agricultural, urban) to different sources.

**Scenario 2 - Evaluate reduction of agricultural water use by increased irrigation efficiency**

Three variations of this modeling scenario were simulated. In scenario 2a, the irrigation efficiency for small vegetable crops was increased to 75 percent for all users currently below that efficiency level. In scenario 2b, the irrigation efficiency for citrus was increased to 85 percent for all users currently below that level. Scenario 2c was a combination of scenarios 2a and 2b. All three model scenarios were simulated by reducing irrigation withdrawals for small vegetable and/or citrus crops in the model runs.

**Scenario 3 - Evaluate increased use of reclaimed water**

Scenario 3 assumed that all of the available supply of reclaimed water in the LWC Planning Area would be utilized to meet irrigation demands. The available supply of reclaimed water was defined as average of the three minimum flow months for each regional wastewater treatment plant in Lee County and the modeled portion of Collier County for the year 2010. This scenario was simulated by reducing well withdrawals and replacing them with reclaimed water.

Nearly all of the projected supply of reclaimed water in the LWC Planning Area is in Collier and Lee counties. Scenario 3 was not simulated in the Hendry County model because the projected reuse in Hendry County is insignificant.

**Scenario 4 - Evaluate implementation of proposed long-term modifications of the Big Cypress Basin canal system**

Simulated modifications to the Big Cypress canal system for scenario 4 included elimination of canals in the Golden Gate Estates South area and addition of control structures on the Miller and Faka Union canals directly north of Alligator Alley. Control elevations for the new structures were set at one foot below land surface to maintain higher water levels north of I-75. This scenario is specific to Collier County and was simulated with the Collier County model by adjusting the simulated canal levels accordingly. The proposed modifications to the Big Cypress canal system include facilities for backpumping water to the Golden Gate Estates North area and other routing of surface water through the canals; however, these modifications cannot be fully represented in the ground water model. This modeling scenario did not evaluate any flood protection aspects of the proposed modifications to the Big Cypress Basin canal system, but rather was an evaluation of ground water levels as related to water supply and wetland impacts only.

A watershed management plan will be developed by the Big Cypress Basin Board within the next year. This watershed management plan should be able to provide more detailed evaluations of the benefits of the proposed modifications.

**Scenario 5 - Evaluate combination of Scenarios 1 and 3**

This scenario has two variations. Scenario 5a combines scenario 1a, in which all water supply withdrawals were removed from the shallow aquifers, with scenario 3, in which irrigation withdrawals were partially replaced by reclaimed water. Scenario 5b combines scenario 1b, in which the increase in public water supply

withdrawals between 1990 and 2010 were removed from the shallow aquifers, with scenario 3.

**Scenario 6 - Evaluate combination of Scenarios 1, 2c, and 3**

Modeling scenario 6 had two variations: (1) scenario 6a, which combined modeling scenario 1a (remove all public water supply from the shallow aquifers), modeling scenario 2c (improving the irrigation efficiency of both small vegetables and citrus), and modeling scenario 3 (increase use of reclaimed water); and (2) scenario 6b, which combined modeling scenario 1b (remove **future** public water supplies from the shallow aquifers), modeling scenario 2c, and modeling scenario 3. Modeling scenarios 1a, 1b, and 3 involved urban water supplies and reclaimed water, neither of which are very large in Hendry County. Scenarios 1a, 1b, and 3 were not simulated for Hendry County. Similarly, modeling scenarios 6a and 6b were not modeled for Hendry County.